How light aversion affects grooming in a mouse model of traumatic brain injury

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Introduction

- Every year 2.8 million Americans endure a traumatic brain injury (TBI), with 68% reporting visual dysfunction and 55% reporting photophobia (i.e., light sensitivity).[1]
- Yet, the cause of photophobia is unknown and little research has been done to assess TBI-induced photophobia in animal models.[2]

But how can we tell if a mouse is sensitive to light if they can't speak?

- Self-grooming is a complex natural behavior that is one of the most frequently performed behavioral activities in rodents[3], which is important in maintaining hygiene and in reducing stress.
- Changes in body (caudal) and head (rostral) grooming can be divided and measured, where an increase in rostral grooming may be a result of light aversion as the mouse is trying to cover their eyes or relieve discomfort.[4]

Hypothesis

Following a TBI, we hypothesize that damage to the visual system will increase light aversion, which will be shown through an increase in rostral grooming.

Methods

Animals – 8-week-old adult male C57BL/6J mice

Traumatic Brain Injury – closed-head weight drop model (Fig. 1a) utilizing a 400 g weight dropped 1.5 cm above bregma (top-front of the skull). Sham mice were anesthetized but did not undergo injury.

Equipment - an optokinetic device (Fig. 1c) was adapted to produce an aversive visual environment with increasing light intensities (80 lux, 400 lux, 1100 lux, and 3200 lux) and a spinning drum. Mice remain stationary on a platform in the center of the device and are recorded for 1 min. in each light once per day.

Grooming Assessment - grooming patterns and the time spent performing rostral (head) and caudal (body) grooming were recorded

Statistical Analyses (Graphpad Prism)
- Rostral vs Caudal: (Rostral/Caudal Grooming x Injury x Light) 3-way ANOVA
- Head:Total Grooming: (Injury x Light) 2-way ANOVA

Results

Figure 1

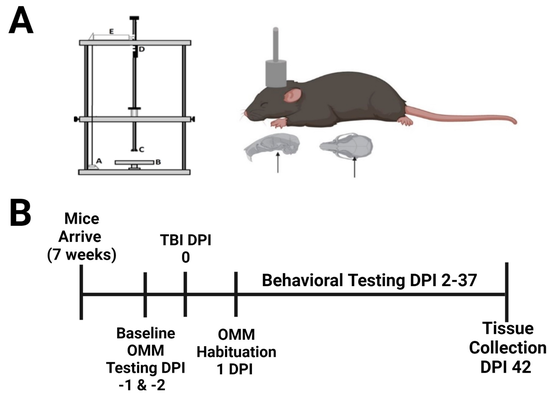

Figure 1. Timeline and Methods. (A) Closed-head weight-drop TBI device. (B) Timeline of experimental procedures. (C) Depiction of the optokinetic device with a visual grating (i.e., the black and white bars). (D) Pictoral examples of mice grooming the paws, head, body, and legs respectively. *Image created using BioRender.*

Figure 2

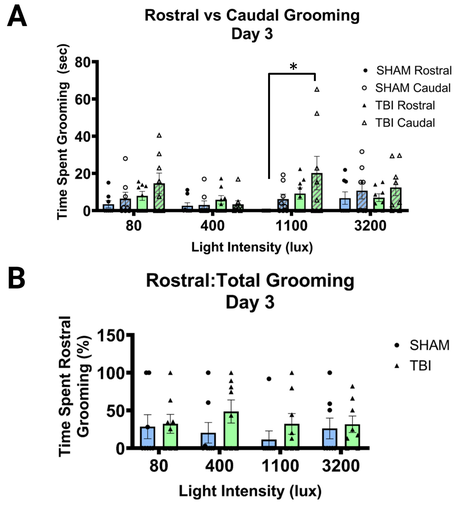

Figure 2. Day 3 Grooming Analysis. (A) Shows a main effect of injury (p=0.02) and rostral vs caudal grooming (p=0.04) where injured mice groomed significantly more caudally than sham mice, but only at 1100 lux. (B) Shows an effect of injury (p=0.04) where TBI mice spent more time grooming rostrally than sham mice. Seconds (sec) * p<0.05.

Figure 3

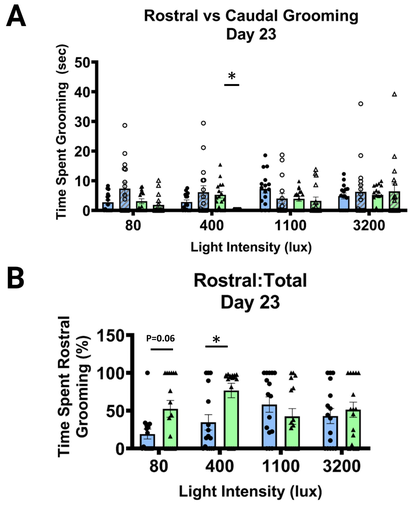

Figure 3. Day 23 Grooming Analysis. (A) Shows an interaction between injury x rostral vs caudal grooming (p=0.03) and between light intensity x injury x rostral vs caudal grooming (p=0.01), where injured mice now groom significantly more rostrally at 400 lux. (B) Shows a main effect of injury (p=0.002) and an interaction between light intensity x injury (p=0.03) showing that TBI mice spent more of their total time grooming on rostral grooming at lower light intensities. Seconds (sec) * p<0.05.

Discussion

- While sham and TBI mice had similar grooming times overall, there were differences acutely at 3 days and chronically at 23 days post injury.
- Acutely, injury leads to increased grooming overall, which could be a result of heightened stress.
- Later, interactions and effects of injury at low light intensities may be a result of light aversion.
- *Although we were able to identify small effects and interactions throughout the study, further testing needs to be done in order to truly assess the impact of light aversion and stress following a TBI.*

Limitations and Future Directions

Limitations
- Only 30s between each light intensity could have oversaturated retinal cells, preventing adequate distinction between lights.
- Grating size could impact the stress of this environment.
- TBI is a bimodal injury.

Future Directions
- Assess the cephalocaudal progression (i.e., natural grooming patterns) and how it was impacted by TBI.
- Separate high groomers from low groomers and analyze them separately.
- Electroretinogram to assess photoreceptor function.

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References

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